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ABSTRACT

This study investigated the effect of learning task, instructional quality, and teacher on three indices of Perseverance: Attending Time, Distractability, and Attention Span. Data were secured from 219 students learning elementary school mathematics in an individualized instruction program, the Individually Prescribed Instruction (IPI) system developed by the Learning Research and Development Center at the University of Pittsburgh. Results indicated that the effect of a lesson on pupil perseverance depends upon the particular student. There was also some evidence that the performance of the teacher is a factor in pupil perseverance. (Author/NS)

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THE EFFECT OF INSTRUCTIONAL VARIABLES ON CERTAIN INDICES OF STUDENT PERSEVERANCE

1969

GEORGE REEF MILLER

UNIVERSITY OF PITTSBURGH

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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THE EFFECT OF INSTRUCTIONAL VARIABLES ON CERTAIN INDICES OF STUDENT PERSEVERANCE

by

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B.S., Ashland College, 1962

M.Ed., University of Pittsburgh, 1963

Submitted to the Graduate Faculty in the School
of Education in partial fulfillment of
the requirements for the degree of
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University of Pittsburgh

1969

FOREWARD

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TABLE OF CONTENTS

Page

FOREWORD ii

LIST OF TABLES iv

I. INTRODUCTION AND RELATED RESEARCH 1

Introduction. 1

Related Research. 4

II. THE PROBLEM 18

Statement of the Problem. 18

Specific Problems 18

Definition of Terms 20

III. RESEARCH DESIGN 23

Setting of the Study. 23

Research Population 25

Measures of Perseverance. 26

Factors Associated with Perseverance. 30

IV. PRESENTATION AND ANALYSIS OF DATA 38

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY 63

Summary 64

Conclusions and Recommendations for Further Study 66

APPENDIX A 70

APPENDIX B 74

APPENDIX C 75

BIBLIOGRAPHY 77

LIST OF TABLES

Table | | Page
1 Number of Students in Grades Two through Six in Oakleaf and McAnnulty Schools Working in Six Selected Units in the Mathematics Continuum for which Data Was Secured 26

2 Inter-Correlations of Perseverance Indices for Four Hundred Sixty-Eight Observations . . 30

3 Means and Standard Deviations for Measures of Attending Time of Students in E-Level Units (In Minutes) 39

4 Means and Standard Deviations for Measures of Distractability of Students in E-Level Units (Number of Intervals of Sustained Attending to Task) 39

5 Means and Standard Deviations for Measures of Attention Span of Students in E-Level Units (In Minutes) 40

6 Analysis of Variance for Numeration, Subtraction and Multiplication Units vs. Individual Attending Time 42

7 Analysis of Variance for Numeration, Subtraction and Multiplication Units vs. Individual Distractability 43

8 Analysis of Variance for Numeration, Subtraction and Multiplication Units vs. Individual Attention Span 44

9 Attending Time Means for Units vs. Quality of Instruction (N=180) 47

10 Analysis of Variance for Attending Time vs. Quality of Instruction and Units 47

11 Distractability Means for Units vs. Quality of Instruction (N=180) 48

Table		Page
12	Analysis of Variance for Distractability vs. Quality of Instruction and Units	48
13	Attention Span Means for Units vs. Quality of Instruction (N=180)	49
14	Analysis of Variance for Attention Span vs. Quality of Instruction and Units	50
15	Perceived Difficulty of Students' E-Level Mathematics Unit (1-Hard; 5-Easy).	52
16	Attending Time Means for Quality of Instruction vs. Perceived Difficulty (N=29/Cell).	53
17	Analysis of Variance of Attending Time vs. Quality of Instruction and Perceived Difficulty	54
18	Distractability Means for Quality of Instruction vs. Perceived Difficulty (N=29/Cell).	55
19	Analysis of Variance of Distractability vs. Quality of Instruction and Perceived Difficulty	55
20	Attention Span Means for Quality of Instruction vs. Perceived Difficulty (N=29/Cell).	56
21	Analysis of Variance of Attention Span vs. Quality of Instruction and Perceived Difficulty	56
22	Mean Attending Time of Fifth-Grade Students in Four IPI Classrooms Studying in Numeration and Multiplication Units	58
23	Mean Distractability of Fifth-Grade Students in Four IPI Classrooms Studying in Numeration and Multiplication Units	58
24	Mean Attention Span of Fifth-Grade Students in Four IPI Classrooms Studying in Numeration and Multiplication Units	58

Table Page

25 Analysis of Variance of Attending Time of Fifth-Grade Classrooms for the Numeration Unit 59

26 Analysis of Variance of Attending Time of Fifth-Grade Classrooms for the Multiplication Unit 59

27 Analysis of Variance of Distractability of Fifth-Grade Classrooms for the Numeration Unit 60

28 Analysis of Variance of Distractability of Fifth-Grade Classrooms for the Multiplication Unit 60

29 Analysis of Variance of Attention Span of Fifth-Grade Classrooms for the Numeration Unit 60

30 Analysis of Variance of Attention Span of Fifth-Grade Classrooms for the Multiplication Unit 61

31 Per Cent of Students Experiencing Specified Instructional Quality in Two Mathematics Units in Four Fifth-Grade Classrooms 62

CHAPTER I

INTRODUCTION AND RELATED RESEARCH

A. Introduction

The current renewed emphasis on the individualization of instruction has served to place additional importance on knowledge of factors affecting the individual's performance in classroom learning situations. Inherent in many programs for individualization is the provision for individual rates of progress and the requirement of some specified degree of mastery of the behaviors that serve to define the instructional program. In order for this type of system to be effective, some degree of self-direction on the part of the learner is required.

This requirement of self-direction compentencies and effective study habits is necessary so that continuing face-to-face interaction between teacher and student is not required. The student, then, in the absence of the direct influence of his teacher, must be able to make certain intelligent decisions concerning his learning program and also be willing to persist at his task until mastery is accomplished.

This concept of perseverance can generally be defined as the willingness on the part of the student to spend time in learning. Other labels, such as attention and persistence have been used to connote this same type of behavior. Carroll[1] has proposed a model for school learning in which perseverance is a key element. He essentially says that learning can be termed efficient if the time a student spends in learning approximates the hypothetical time that he needs to learn the task in terms of his ability. This time that a student spends in learning is then a function of his perseverance, the quality of the instruction he received, and the time available for learning. This model basically reflects the problem of individual differences between children and the considerations that must be given to adapt an instructional program to these differences.

One possible source of variance in perseverance of students could be the quality of instruction which they received, another Carroll variable. This quality has two dimensions. One is the aspect of effectiveness, that is, did the instruction lead the child to the acquisition or mastery of the desired behavior? The other is the efficiency with which this was accomplished or the extent to which the instruction leads the child to the desired behavior with a minimum amount of failure and in a time commensurate with his abilities. For instructional quality to be optimal for an individual, it must be both effective and efficient. It is then evident that instruction can be effective, but at the same time quite inefficient.

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[1] John B. Carroll, "A Model of School Learning," Teachers College Record, 64:723-32, 1963.

Another aspect of instructional quality is the student's perception of its difficulty for him. It is possible that this could have a bearing on his willingness to attend to the task at hand. Closely related to instructional quality is the specific nature of the instructional content and the skill to be learned. Carroll[1] himself has suggested that many important determiners of a pupil's achievement may be specific to the given learning task. This would suggest the desirability of studying the impact of learning task on perseverance.

Rather obviously, another important factor to investigate is the teacher. The teacher largely controls the learning environment even in an individualized setting. He is responsible for planning the learning activities of pupils and also sets the mood of the classroom. He is a major reinforcer of pupil behavior. These, plus other factors, make for differences between teachers which could affect the time a student is willing to persist in learning.

To provide a meaningful and effective program of individualization, it is desirable that variables be identified which act as agents in determining the motivation of the student and his willingness to persevere in such an environment. When these can be isolated and understood, it is likely that learning can be more efficiently and effectively adapted to individual differences.

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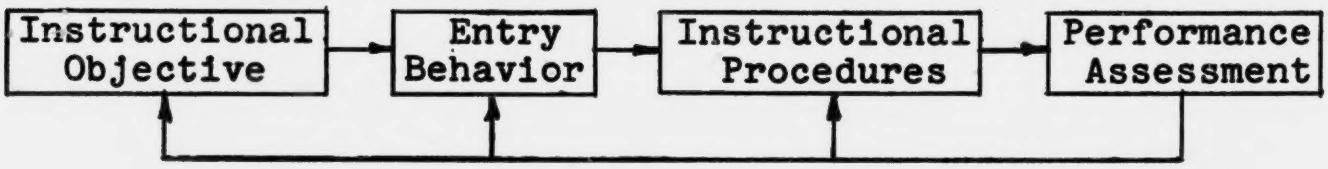
[1] Ibid.

B. Related Research

Glaser[1] developed a model for individualized instruction which divides the instructional process into four components. These parts are: (1) Instructional Objective; (2) Student Entry Behavior; (3) Instructional Procedures; and (4) Performance Assessment. This interrelationship may be described as follows:



The instructional objective is that behavior the student is expected to acquire after instruction. The entry behavior describes the student's level of competence before instruction. This includes his existing ability in the desired behavior and certain non-cognitive variables where deemed important in planning instruction. Instructional procedures are the decisions made relative to the entry behavior which bring the student to the desired objective. The last step is the measurement of the level of proficiency of the behavior after instruction. If this does not reach a desired state, the student may be recycled through any or all of the other components as shown by the arrows.

Carroll's[2] school learning model equates "degree of learning" or achievement with the ratio of the time spent in learning to the time needed for learning.

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[1] Robert Glaser, "Psychology and Instructional Technology," in Robert Glaser (ed.), *Training Research and Education* (Pittsburgh: University of Pittsburgh Press, 1962).

[2] Carroll, *op. cit.*

$$\text{degree of learning} = f\left(\frac{\text{time actually spent}}{\text{time needed}}\right)$$

The factors influencing the optimum time needed for a student to master a specific task would be (1) his aptitude for learning this task; (2) his ability to understand the instruction; and (3) the quality of the instruction given to achieve this task. In actuality this time is directly proportional to pupil aptitude and to the quality of instruction, when this is less than optimal for the student, and inversely related to the student's ability to understand the instruction.

The time the student actually spends in learning is defined as being the least of these values: (1) the opportunity or the time allowed for learning; (2) the time the student is willing to persevere in learning; and (3) the learner's aptitude (defined as time required under optimum conditions) increased by the amount of additional time necessary in view of poor quality of instruction and the lack of ability to understand less than optimum instruction.

Of the five variables in this model, three are characteristics of the learner: (1) aptitude, (2) ability to understand instruction, and (3) perseverance. The other two, (4) quality of instruction and (5) opportunity for learning, stem from external factors.

The components of this model can be compared to those in the Glaser model. The "degree of learning" resulting from the application of the Carroll model would be only for one instructional objective when applied to Glaser's model for individualized learning. The student's aptitude, perseverance, and ability to understand instruction could be considered entry behaviors. Quality of instruction and opportunity would then be factors in instructional procedures. The final assessment would be in terms of mastery of the stated objective.

The individualized model for teaching[1] superimposes on the general model the concept of mastery and of efficiency of instruction in that individual students, because of their entry behavior, may learn at different rates. Therefore, for an individual student, instructional objectives and procedures are selected in terms of entry behavior variables. This instruction continues until the desired behavior has been mastered.

While it has been demonstrated that many variables affect academic performance, it is the purpose of education to provide the necessary resources to mediate these effects. To do so, research must center both on identification of achievement-predictor variables and the sources of variance in these variables. Obviously this must include both cognitive and non-cognitive factors. An implication of the Carroll model for school learning is that the non-cognitive variable of perseverance is deemed an important enough determiner of "degree of learning" to be included in the model. In observing any learning environment, it is obvious that some students are not attending to their learning task. The cause of this state of behavior is no doubt a function of many variables: cognitive, non-cognitive, and environmental. Bloom comments on individual differences in this behavior:

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[1] Robert Glaser, "Adapting the Elementary School Curriculum to Individual Performance," Preprint 26 (Pittsburgh: Learning Research and Development Center, University of Pittsburgh, 1967), and C. Mauritz Lindvall and John O. Bolvin, "Individually Prescribed Instruction: The Oakleaf Project," Working Paper 8 (Pittsburgh: Learning Research and Development Center, University of Pittsburgh, 1966).

> We do believe that students vary in the amount of perseverance they bring to a specific learning task. However, students appear to approach different learning tasks with different amounts of perseverance. It would appear to us that as a student finds the effort rewarding, he is likely to spend more time on a particular learning task.[1]

Carroll defined this term as the time the student is willing to spend learning his assigned instructional task to a specified criterion of mastery. This "attending to learning" is referred to by several terms. In addition to perseverance, "attention" and "persistence" have been used in the literature to describe this state of behavior. Berlyne relates the use of the term "attention" in psychology:

> The word 'attention' has had more varied usages than, perhaps, any other in psychology. It has, however, commonly been thought of as something with both intensive and selective aspects. On the one hand, it has been used to refer to processes that determine an organism's degree of alertness or vigilance, i.e. how effectively behavior is being controlled by the stimulus field as a whole. On the other hand, it has been applied to the processes that determine which elements of the stimulus field will exert a dominating influence over behavior. These

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[1] Benjamin S. Bloom, "Learning for Mastery," Evaluation Comment, Vol. 1, No. 2, May, 1968, p. 6.

> are logically two distinct functions, but it is widely felt that closely related processes must be responsible for both.[1]

Others define "attention" to be "the process of bringing the sense organs to bear upon some subset of stimuli out of the many available in one's perceptual field."[2] A similar one is proposed by Vohs. He identifies "attention" as "responding selectively under conditions of multiple stimulation."[3]

Persistence is described in a different sense by Brandwein.

> This is defined as consisting of three attitudes. (1) A marked willingness to spend time, beyond the ordinary schedule, in a given task (this includes the willingness to set one's own time schedule, to labor beyond a prescribed time. (2) A willingness to withstand discomfort. This includes adjusting to shortened lunch hours, or no lunch hours, working without holidays, etc. . . (3) A willingness to face failure. With this comes a realization that patient work may lead to a successful termination of the task at hand.[4]

From these descriptions it could be posed that the optimum state of this attending behavior for an individual would be achieved when the strength of the stimulus associated with the learning task is such that it overpowers all other competing stimuli present. This then would imply that individual differences in "perseverance" would therefore be a function of both the nature of the stimulus and the "stimulus-receiving" variability of individuals. Glaser mentions in a review of research on learning:

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[1] D. E. Berlyne, Conflict, Arousal, and Curiosity (New York: McGraw-Hill Book Co., Inc., 1960), p. 45.

[2] William D. Coats and Uldis Smedchen, "Audience Recall as a Function of Speaker Dynamism," Journal of Educational Psychology, 57:189-91, 1966, p. 189.

[3] John L. Vohs, "An Empirical Approach to the Concept of Attention," Speech Monographs, 31:355-60, August, 1964.

[4] P. F. Brandwein, The Gifted Student As Future Scientist (New York: Harcourt-Brace, 1955), pp. 9-10.

> Experiments show that differences between the brighter and duller subjects are not in the slopes of their learning curves but in the length of the initial plateau. This implies that it is not the rate of learning that distinguishes bright and dull, but how long it takes the attentional response to discriminate out the relevant stimulus cue; after this occurs, improvement is uniformly fast for both groups. The general postulation is that there are two aspects of learning involved; one aspect controlling any individual differences in the rate of acquisition and extinction, and the other controlling individual differences in the probabilities of paying attention to the stimulus dimensions.[1]

Individual differences in attending power have been shown in several studies. Billing[2] found the average time subjects could attend to a supreliminal stimulus without permitting any other idea to occupy their consciousness to be two seconds. Bee's[3] results showed consistent individual differences in distractability for high-school females, but little for males.

Academic performance has been related to various measures of this behavior. Perkins[4] compared upper middle class fifth grade under-achievers and achievers in classroom behavior. He concluded that these groups do differ in the "withdrawing" category. Baker and Madell[1] found greater susceptibility to distraction in underachieving than in achieving male college students.

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[1] Robert Glaser, "Learning," preprint of a chapter to appear in the Encyclopedia of Educational Research, 4th Ed. (Pittsburgh: Learning Research and Development Center, University of Pittsburgh, 1968).

[2] M. LeRoy Billing, "The Duration of Attention," The Psychological Review, 21:121-35, 1914.

[3] Helen L. Bee, "Individual Differences in Susceptibility to Distraction," Perceptual & Motor Skills, 23:821-22, 1966.

[4] Hugh V. Perkins, "Classroom Behavior and Underachievement," American Educational Research Journal, 2:1-12, January, 1965.

Working with college students, MacArthur[2] administered an eight-test battery defining a general persistence factor. The results when correlated with school achievement showed perseverance to have a low correlation with achievement, although significantly different from zero ($r = .25$).

LaLaderne[3] related visible measures of attention of sixth grade students to their attitudes toward school and to their achievement. Though she found practically no relation between attention and attitude, correlations of .37 to .53 were found between the attention measures and achievement test scores. She concluded that the attentive pupil tended to be above average in achievement and intelligence.

Merrill and Murphy[4] reported that for a sample of low ability college students, the endurance scale of the Edwards Personal Preference Schedule differentiated between those compiling successful and unsuccessful academic records. In another study of college achievement, Weigand[1] found with probationary students, that those who were successful academically were able to persist toward their objectives in the face of adversity, while the unsuccessful ones were not able to do so.

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[1] Robert W. Baker and Thomas O. Madell, "A Continued Investigation of Susceptibility to Distraction in Academically Underachieving and Achieving Male College Students," Journal of Educational Psychology, 56:254-58, 1965.

[2] Russell S. MacArthur, "An Experimental Investigation of Persistence in Secondary School Boys," Canadian Journal of Psychology, 9:42-54, 1955.

[3] Henriette LaLaderne, "Attitudinal and Intellectual Correlates of Attention: A Study of Four Sixth-Grade Classrooms" (paper read at the meeting of the American Educational Research Association, New York, February, 1967).

[4] Reed M. Merrill and Daniel T. Murphy, "Personality Factors and Academic Achievement in College," Journal of Counseling Psychology, 6:207-10, 1959.

These results should be viewed with care, in that while achievement may be determined by the level of persistence, achievement may act as a feedback variable which in turn affects future attention behavior.

Other studies have centered on identifying variables which tend to be determiners of levels of attending behavior. Previous research has demonstrated that certain environmental conditions appear to affect the level of this behavior. In a study of high and low "need for achievement" groups, Shrable[2] reported that both groups attended to task more in quiet than under noise or music distraction. Baker and Madell[3] found that underachieving college freshmen were susceptible to distraction from background noise.

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[1] George Weigand, "Adaptiveness and The Role of Parents in Academic Success," Personnel and Guidance Journal, 35:518-22, 1957.

[2] Kenneth Shrable, "Effects of Achievement Motivation and Noise Conditions on Paired-Associate Learning," California Journal of Educational Research, 19:5-15, January, 1968.

[3] Baker and Madell, op. cit.

Coats and Smedchen[1] found for college students, retention of orally presented material was higher when the speaker was termed "dynamic." Similar results were reported in a study by Vohs.[2] It would appear then that the subjects who retained more of the material paid more "attention" to the dynamic speaker.

Bridges'[3] results showed that the amount of attention of fourth, fifth and sixth grade students to three educational television programs was a function of viewing time. Burns[4] compared the effects of audio and visual presentations on intermediate grade students. His results indicated a high level of attention at the beginning of each presentation, but no overall relationship between the mode and the occurrence of inattention. He did note, however, a marked difference in attention from student to student.

A discussion of factors related to attentive behavior must include the influence of the teacher. It is quite difficult to discern the source of gross teacher effectiveness, for this is affected by his personality, his ability to control the classroom, and most important, his instructional ability. Ryans notes in a study of teacher-student behavior:

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[1] Coats and Smedchen, op. cit.

[2] Vohs, op. cit.

[3] Cecil C. Bridges, Jr., "An Attention Scale for Evaluating E.T.V. Programs," Journal of Educational Research, 54:149-52, December, 1960.

[4] John Walter Burns, "An Exploratory Study of Assumed Attention Given to Audio and Visual Elements in an Elementary Science Television Series" (unpublished doctoral dissertation, Wayne State University, 1966).

> For elementary school classes, high positive relationships were noted between observers' assessment of 'productive pupil behavior' (e.g. assessments presumed to reflect pupil alertness, participation, confidence, responsibility and self-control, indicating behavior, etc.) and observers' assessments of previously identified patterns of teacher behavior which seemed to refer to understanding, friendly classroom behavior, organized, businesslike classroom behavior, and vibrating, original classroom behavior.[1]

Ripple[2] concluded his review of research of affective factors influencing learning by stating that the goals of instruction would be facilitated if the qualities of teachers and classrooms are characterized by: (1) a feeling of general warmth; (2) tolerance of moderate expression of emotion and feeling by students; (3) democratic group decision making leading to stimulating activities; (4) the use of non-punitive control techniques high in clarity and formness; (5) reduced frustration and anxiety in learning situation; and (6) shifting states of order based on organizing emotions toward the achievement of goals.

Christensen[3] also found relationships between vocabulary and arithmetic achievement of fifth graders and measures of their teachers on the "warmth" scale.

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[1] David Ryans, "Some Relationships Between Pupil Behavior and Certain Teacher Characteristics," Journal of Educational Psychology, 52:82-90, April, 1961, p. 89.

[2] Richard E. Ripple, "Affective Factors Influence Classroom Learning," Educational Leadership, 22:476-80, April, 1965.

[3] Clifford M. Christensen, "Relationship Between Pupil Achievement, Pupil Affect-Need, Teacher Warmth, and Teacher Permissiveness," Journal of Educational Psychology, 51:169-74, 1960.

In an early study of student attention, Morrison[1] drew the conclusion that there is a high correlation between teachers' "control techniques" and their gross effectiveness as classroom technicians. French[2] found a correlation of .82 between the rating of teacher ability and measures of group attention. His results also indicated that measures of group attention were slightly higher in the upper grades than in the early elementary grades.

One aspect of classroom control is the ability of the teacher to reinforce proper behavior. Stevenson[3] sees that there might be a difference between the sexes as to their effectiveness as reinforcers. Women who tended to be better with young children were less effective with older children, while men who were effective with young children were also effective reinforcers with older children.

Some research has been reported that relates instruction to student attention. Bjarnason,[4] in studying the relationship between class size and attention, concluded that group attention was affected more by the technique employed by the teacher than by the size of the class.

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[1] Henry C. Morrison, The Practice of Teaching in the Secondary School (Chicago: University of Chicago Press, 1927).

[2] William C. French, "The Correlation Between Teaching Ability and Thirteen Measurable Classroom Activities" (unpublished master's thesis, University of Chicago, 1924).

[3] Harold W. Stevenson, "Social Reinforcement with Children as a Function of CA, Sex of E. and Sex of S.," Journal of Abnormal and Social Psychology, 63:147-54, July, 1961.

[4] L. Bjarnason, "Relation of Class Size to Control of Attention," Elementary School Journal, 26:147-54, July, 1961.

A study[1] of various teaching procedures found student reports and demonstrations to be more effective in holding attention than other methods. While the laboratory method produced the poorest attention, the use of the workbook secured a moderate level.

Washburne[2] and his colleagues at Winnetka compared the attentiveness of students learning in an individualized study program with those in a more traditional program. They found the Winnetka students to be slightly more inattentive than those in the traditional classroom.

This instructional ability of the teacher might tend to mediate the individual differences in student perseverance. To do so, it may be necessary to adapt the program of instruction to the needs and abilities of the students. Carroll states his view as to quality of instruction as he perceives it in relation to his model.

> One job of the teacher (or any person who prepares the materials for instruction) is to organize and present the task to be learned in such a way that the learner can learn it as rapidly and as efficiently as he is able. This means, first, that the learner must

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[1] R. W. Edmiston and R. W. Bradduck, "A Study of the Effect of Various Teaching Procedures Upon Observed Group Attention in the Secondary School," Journal of Educational Psychology, 32:665-72, 1941.

[2] Carleton Washburne, Mabel Vogel, and William S. Gray, Results of Practical Experiments in Fitting Schools to Individuals: A Survey of the Winnetka Public Schools (Bloomington, Illinois: Public School Publishing Co., 1926).

> be told in words that he can understand, what he is to learn and how he is to learn it. It means that the learner must be put into adequate sensory contact with this material to be learned. . . It also means that the various aspects of the learning task must be presented in such an order and with such detail that, as far as possible, every step of the learning is adequately prepared for by the previous step. It may also mean that the instruction must be adapted for special needs and characteristics of the learner, including his stage of learning. . . This variable applies not only to the performance of a teacher but also to the characteristics of textbooks, workbooks, films, teaching machines, programs, etc.[1]

From the results of previous research studies on attending behavior in classroom learning, one can draw the following conclusions and inferences.

1. There are individual differences in attending to a learning task. (Billings, Burns, Carroll).

2. These individual differences in attention are a function of aptitude characteristics of the learner. (Perkins, Baker and Madell, LaLaderne, Merrill and Murphy, Weigand).

3. These individual differences may be also attributed in part to classroom environmental variables controlled by the teacher. (Shrable, Baker and Madell, Coats and Smedchen, Vohs, Bjarnason, Morrison, French, Stevenson, Edmiston and Bradduck).

4. These differences may also be attributed to the type and quality of instruction. (Washburne, Carroll, Bloom).

5. These may also be influenced by the task. (Carroll, Bloom).

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[1] Carroll, op. cit., p. 726.

This study investigates these same factors and their interrelationships in classrooms operating on an individualized basis. The use of group attention measures, rather than measures of each individual, and certain lacks in adapting instruction to the abilities of the individual student limit the applicability of the findings of past research to the individualized instruction situation. This study has attempted to meet these limitations in that observations of individual attending behavior are used for analysis rather than group measures. Also, certain adjustments for pupil aptitude variables could be provided since the subjects used in this study were learning in an individualized instructional setting.

CHAPTER II

THE PROBLEM

This study is concerned with the problem of ascertaining the relationship of selected instructional variables to student Perseverance. To do this, it has investigated the effect of learning task, instructional quality, and teacher on three indices of Perseverance: Attending Time, Distractability, and Attention Span.

A. Statement of the Problem

What are some instructional factors associated with individual differences on selected measures of perseverance-in-learning of students studying elementary school mathematics in an individualized school setting?

B. Specific Problems

1. Is there a significant difference in students' Attending Time between different units of instruction?

2. Is there a significant difference in students' Distractability between different units of instruction?

3. Is there a significant difference in students' Attention Span between different units of instruction?

4. Is there a significant difference between the Attending Time of students who receive high quality

instruction and the Attending Time of students who receive low quality instruction?

5. Is there a significant difference between the Distractability of students who receive high quality instruction and the Distractability of students who receive low quality instruction?

6. Is there a significant difference between the Attention Span of students who receive high quality instruction and the Attention Span of students who receive low quality instruction?

7. Is there a significant difference between the Attending Time of students who perceive their instructional activities to be easy and the Attending Time of students who perceive their instruction to be difficult?

8. Is there a significant difference between the Distractability of students who perceive their instructional activities to be easy and the Distractability of students who perceive their instruction to be difficult?

9. Is there a significant difference between the Attention Span of students who perceive their instructional activities to be easy and the Attention Span of students who perceive their instruction to be difficult?

10. Is there a significant difference in the Attending Time of students who are instructed by different teachers?

11. Is there a significant difference in the Distractability of students who are instructed by different teachers?

12. Is there a significant difference in the Attention Span of students who are instructed by different teachers?

13. Is there a significant difference in Attending Time among students studying in different units?

14. Is there a significant difference in the Distractability among students studying in different units?

15. Is there a significant difference in the Attention Span among students studying in different units?

C. *Definition of Terms*

1. *Individually Prescribed Instruction (IPI)* - A system of instruction which permits the planning of learning experiences based upon the learner's entry behavior and learner characteristics. The structure of this system permits students to work at different rates on different content in the same classroom.

2. *IPI Mathematics Continuum* - A listing of the behaviorally stated objectives of the curriculum. These objectives are organized into thirteen topical areas with eight levels of increasing mathematical complexity.

IPI MATHEMATICS CONTINUUM

Topics	Levels							
	A	B	C	D	E	F	G	H
Numeration								
Place Value								
Addition								
Subtraction								
Multiplication								
Division								
Combination of Processes								
Fractions								
Money								
Time								
Systems of Measurement								
Geometry								
Special Topics								

3. IPI Mathematics Unit - The objectives of a particular topic at a given level, i.e., E-Numeration.

4. Perseverance - The ability of the learner to attend to learning as measured by these indices:

   a. Attending Time (AT) - An indication of the amount of time the pupil is observedly attending independently, to his learning task. The measure is derived for each observation by this formula:

$$AT=\frac{\text{Total Time in Independent Study}}{\text{10 Minutes-Time Working with Others}} \times 10$$

   b. Distractability (D) - An indication of how the pupil applies himself to learning for sustained periods. This is measured by counting the number of sustained periods of attending independently to the learning task for each observation. The pupil would be considered to be more distractable as the number of these periods increases.

   c. Attention Span (AS) - An indication as to the length of time the pupil spends in sustained application to his learning task. This is computed for each observation by this formula:

$$AS=\frac{\text{Attending Time}}{\text{Distractability}}$$

5. Instructional Task - The desired behaviors to be learned as specified by the Continuum. For this investigation, the objectives of a unit will be considered the task.

6. Instruction - The activities prescribed for the pupil to guide him to the desired behavior.

7. Instructional Quality - The degree to which the presentation, explanation, and ordering of the elements of the task to be learned approaches the optimum for a given learner. The effectiveness and efficiency aspect is measured by the number of posttests required of the pupil to gain mastery of the instructional task. This is operationally defined as follows:

Quality of Instruction (High) - Instruction for which only one posttest was required.

Quality of Instruction (Low) - Instruction for which more than one posttest was required.

The pupil's reaction to his instructional activities is measured by his response to the question, "Was this work hard or difficult for you?"

CHAPTER III

RESEARCH DESIGN

A. Setting of the Study

To investigate the relationship between the selected instructional variables used in this study and Perseverance in the classroom setting, it was necessary that these variables be measurable and that they be operating in a system where they were adapted to individual differences. For this reason, the data were secured from students learning elementary school mathematics in two schools employing an adaptive program of study called Individually Prescribed Instruction (IPI). These two schools, Oakleaf and McAnnulty Elementary Schools, are located in the Baldwin-Whitehall School District in suburban Pittsburgh.

The IPI system is being developed and tested by the Learning Research and Development Center at the University of Pittsburgh. The essential elements of this program include: (1) detailed specification of the behaviors a child is to acquire; (2) procedures for each objective and instructional materials which are largely self-instructional; (3) a program of testing which results in diagnostic information and assists in monitoring student progress; and (4) a classroom management system which provides for individual rates of progress and methods of planning individual programs of study.

The IPI Mathematics program for grades K-6 contains approximately four hundred objectives organized into thirteen areas of study (numeration, place value, addition, subtraction, multiplication, division, combination of processes, fractions, money, time, systems of measurement, geometry and special topics). For organizational purposes, these areas are divided into increasing levels of difficulty (A, B, C, D, E, F, G, H). A student in his progress through this curriculum generally works through all areas on a level before proceeding to the next higher level. The area of study in a level is termed a unit such as Level E-Numeration. Units contain varied numbers of objectives depending upon the terminal behavior of the unit and the prerequisites needed in that topic for future study.

For diagnostic and monitoring purposes, several criterion-referenced instruments have been developed for use with the program:

Placement Test - This test gives information as to the unit a student should begin studying when entering the program.

Pretest - The unit pretest provides information as to the degree of mastery of each objective in the unit. This then determines the objectives for which instruction is needed.

Curriculum Embedded Test - This test monitors student progress within a unit. It acts as a short posttest for each objective and also provides diagnostic information for the next objective.

Posttest - The unit posttest acts as a measure of shortterm retention of each objective in the unit. This is used as a criterion of mastery of the unit and determines whether the child may proceed to another unit or needs additional instruction in this unit.

The materials used for teaching in this individualized program are largely self-instructional. These are generally in a workbook format, although alternate modes and materials are provided for some objectives. The inductive method of instruction is the primary means of presenting the lesson, although other strategies are implemented as the need arises.

To provide for individual rates of learning within a conventional-sized classroom, certain managerial procedures and extra personnel have been included in the IPI program. All instructional materials are coded whereby the teacher may efficiently prescribe for a pupil. Teacher aides relieve the teacher of test-checking and various management duties.

B. Research Population

The research population of this study consisted of students from the Oakleaf and McAnnulty Elementary Schools who were studying mathematics in the (1) Numeration, (2) Place Value, (3) Addition, (4) Subtraction, (5) Multiplication, and (6) Combination of Processes units of Level E of the IPI Mathematics Continuum between September 1967 and January 1968 (Table 1). These units were selected because they are representative of the units of the Continuum and a wide range of students study them in a given year. The subjects selected were all of those who were working in these units during the period of this study.

TABLE 1

NUMBER OF STUDENTS IN GRADES TWO THROUGH SIX IN OAKLEAF AND McANNULTY SCHOOLS WORKING IN SIX SELECTED UNITS IN THE MATHEMATICS CONTINUUM FOR WHICH DATA WAS SECURED*

	Units in Level E					
Grade	Num.	P.V.	Add.	Sub.	Mult.	C.O.P.
2	2	1	1	0	0	0
3	6	1	1	3	2	0
4	34	12	4	11	16	6
5	68	27	7	32	50	9
6	66	12	11	23	38	25
Total	176	53	24	69	106	40

*Represents 219 different students.

C. Measures of Perseverance

Perseverance, in the general sense, is the ability and willingness on the part of the learner to apply himself to learning. Carroll in his "A Model of School Learning" argues that this variable is a key determiner of achievement or "degree of learning" in that this influences the time spent in learning. Since the unifying unit of measure in this model is time, he defines perseverance as "the time the learner is willing to spend in learning."[1]

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[1] John B. Carroll, "A Model of School Learning," Teachers College Record, 64:723-32, 1963, p. 728.

The indices of Perseverance used in this study are derived from student observation data collected by members of the evaluation staff of the Learning Research and Development Center between September 1967 and January 1968. This pool of data was secured by observing the activities of students learning in the six different units of IPI mathematics in the two schools mentioned earlier. Each student was observed for three ten-minute periods while studying in one of the six units. The period of time, to the second, the student was observed performing the following behaviors was recorded:

1. Student works independently.
2. Student works with other person.
3. Student is not working.

The student was considered to be working independently if it was observable that he exhibited one or more of these behaviors:

1. Student studies his assigned task.
2. Student retrieves learning materials.
3. Student returns to his study if waiting for his teacher or an aide.

He was considered working with another person if this interaction had a bearing on his learning task. All other behaviors were considered not to be a manifestation of attending to the learning task; the time was recorded as "not working."

These raw data were converted into three different indices of Perseverance. Though Carroll's definition[1] of of perseverance is clear, it does not in a sense reflect how the student applied himself in spending time in learning. For instance, two children may have persevered at a task for 60 minutes, but can the quality of this be termed equal if the total lapsed time for one was 70 minutes and the other 120 minutes?

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[1] *Ibid*.

To compensate for this apparent inconsistency of the meaning of perseverance, using the strict Carroll definition, three indices of Perseverance were used in this study. One, called Attending Time, is an indication of the amount of time the pupil is observably attending independently to his task.

Another index is Distractability. This dimension describes Perseverance in terms of how the student applies himself for sustained periods. This could differentiate between two students who had equal Attending Time, but one took more "breaks" than the other.

The third index is the Attention Span of the child. This describes more fully how the student applies himself to the task in terms of the length of time he is willing to spend in sustained application to this work.

Derivation of Indices of Perseverance

Attending Time (AT) - This is an index of the amount of time a student is engaged independently in learning. Since this measures how the child is observably engrossed in independent learning without the direct influence of another person, measures for certain students had to be corrected for "time working with others" so the measures could be compared. This correction was accomplished by this formula:

$$\text{Attending Time (AT)} = \frac{\text{Total Time in Independent Study}}{\text{10 Minutes-Time Working with Others}} \times 10$$

This correction was made in each ten-minute observation period where needed.

Distractability (D) - This is an indication of the number of sustained periods of time the student is observably engaged in independent learning. Measures of this index were derived from the observation form by counting the number of entries in the "student works independently" row. Since this index reflects the shifting behavior of the students in a ten-minute sample period, the student would be considered to be more distractable as the number of these intervals increases.

Distractability (D)=Number of sustained periods of independent attending to task in a 10-minute period.

Attention Span (AS) - This measure gives an indication of the length of time the student is observably engaged in sustained independent study. This is computed from the Attending Time and the Distractability by the following formula:

$$\text{Attention Span (AS)} = \frac{\text{Attending Time (AT)}}{\text{Distractability (D)}}$$

The use of this measure would differentiate between students who had equal Distractability, but unequal Attending Time.

Table 2 gives the inter-correlations between these measures for all subjects in the research population. These correlations suggest that the indices are measuring some common factor but also have considerable uniqueness.

TABLE 2

INTER-CORRELATIONS OF PERSEVERANCE INDICES FOR FOUR HUNDRED SIXTY-EIGHT OBSERVATIONS

	Attending Time	Distractability	Attention Span
Attending Time	1.00	-.55	.64
Distractability		1.00	-.81
Attention Span			1.00

D. Factors Associated with Perseverance

To understand more fully the nature of Perseverance, it is important to identify factors which affect it in a school setting. The factors in this investigation can be termed instructional in nature. The following are the variables used together with reasons why they are hypothesized to be determiners of Perseverance:

1. Instructional Task - The effect of the instructional task is analyzed by comparing the Perseverance of students studying in different units of the IPI Mathematics Continuum.

Both Yeager[1] and Wang[2] concluded in studies of various learning rate measures that the rate is peculiar to the instructional task. Moyer and von Hollen[1] found that the attention span of children was specific to a particular task. Carroll[2] specifies that his learning model is additative over several tasks, thus accounting for possible task difference. Bloom[3] also suggests that subjects bring to a task varying amounts of perseverance. Hence, the effect of task was investigated.

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[1] John L. Yeager, "Measures of Learning Rates for Elementary School Students in Mathematics and Reading Under a Program of Individually Prescribed Instruction" (unpublished doctoral dissertation, University of Pittsburgh, 1966).

[2] Margaret Wang, "An Investigation of Selected Procedures for Measuring and Predicting Rate of Learning in Classrooms Operating Under a Program of Individualized Instruction" (unpublished doctoral dissertation, University of Pittsburgh, 1968).

2. Instructional Quality - Much research over the past fifty years has been centered on identifying the one instructional method, material, or program that is best for all students. Most of these results have been inconclusive. Opposed to this attack is the identification of instructional methods that are best suited to the abilities and learner characteristics of individual students. This is the essence of an individualized program.

Carroll[4] defines the quality of instruction in terms of the degree to which the presentation, explanation, and ordering of elements of the task to be learned approach the optimum for a given learner. This implies, therefore, in the individualized classroom that learning activities planned for an individual student be based upon the proper diagnosis of entry behavior and these activities be monitored throughout the period of instruction in order to revise the plan. Glaser points out the importance of the latter:

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[1] K. Moyer and G. von Hollen, "Attention Spans of Children for Experimentally Designed Toys," Journal of Genetic Psychology, 87:187-201, 1955.

[2] Carroll, op. cit.

[3] Benjamin S. Bloom, "Learning for Mastery," Evaluation Comment, Vol. 1, No. 2, May, 1968.

[4] Carroll, op. cit.

> Assessment and performance are interlinked, one determining the nature and requirement for the other. Instruction proceeds as a function of the relationship between measures of student performance, available instructional alternatives, and learning criteria which are chosen to be optimized. The question of which criteria are to be optimized becomes critical. Is it retention, transfer, the magnitude of difference between pre- and posttest scores, motivation to continue learning including the ability to do so with minimal instructional guidance, or is it all of these? If teaching of the instructional process permits instruction to become precise enough, then a good job can be done to optimize some gains and minimize others unless the presence of the latter gains is desired, expressed, and assessed. The outcomes of learning measured at any point of instruction are referenced to and evaluated in terms of competence criteria and the values to be optimized; provision is always made for the ability of humans to surpass expectations.[1]

The type of instruction a child receives may be related to his level of perseverance in that the responses required of him are incompatible with his entry behavior. Stevenson comments on this point:

> In most learning situations a child gains little by persisting in a task for which his responses are inappropriate, his ability inadequate, or his information insufficient. A child will try, if at first he succeeds, only if it is clear to him that by continuing to try he will eventually be able to master the problem. A teacher interested in developing persistence in children must first provide problems in which persistence will have a positive consequence for the child.[2]

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[1] Robert Glaser, "Evaluation of Instruction and Changing Educational Models," Occasional Report No. 13 (Los Angeles: Center for the Study of Evaluation of Instructional Programs, University of California at Los Angeles, September, 1968), p. 7.

[2] Harold Stevenson, "Persistence," in Jerome Bruner (ed.), Learning About Learning: A Conference Report (Washington, D.C.: United States Department of Health, Education and Welfare, 1966), p. 22.

Perseverance is related to motivation.[1] McKeachie[2] supports the idea that the method of instruction interacts with the motives of the student in determining his learning outcomes. Therefore, if instruction is such that it gives the student incentive to learn and the expectancy of success, the motivation will be maximized.[3]

Bloom[4] and Carroll[5] both hold that if the instruction is attuned to the qualities of the learner, perseverance in the task can be increased. Two aspects of instruction are deemed important by these men. One is the degree to which concepts and skills are presented to the learner in such a way that he may comprehend and learn. The other aspect is the management of the learning whereby reinforcement, review and feedback of results are presented to the learner at appropriate times.

Instruction, therefore, is some formal arrangement made for a student to guide him from his level of entry behavior to the desired consequence or objective. The measure of how appropriate this instruction was for the individual can be termed its "quality."

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[1] John B. Carroll, "School Learning Over the Long Haul," in John D. Krumboltz (ed.), Learning and the Educational Process (Chicago: Rand McNally and Co., 1965).

[2] W. J. McKeachie, "Motivation, Teaching Methods, and College Learning," in M. R. Jones (ed.), Nebraska Symposium on Motivation: 1961 (Lincoln: University of Nebraska Press, 1961).

[3] John W. Atkinson, "Motivational Determinants of Risk-Taking Behavior," Psychological Review, 64:359-72, 1957.

[4] Bloom, op. cit.

[5] Carroll, 1965, op. cit.

To actually measure this variable in terms of an individual, certain inferences must be made concerning the dimensions of instructional quality. One has to do with the effectiveness and the efficiency of the instruction provided. Bloom,[1] Karwin,[2] and Lucio and McNeil[3] all agree that these are viable constructs to describe instruction.

Effectiveness has to do with the extent to which the instruction resulted in learning the desired outcome. On the other hand, efficiency implies some dimension of minimum time to reach the objective. A sequence of instruction may be quite effective, but inefficient in terms of the amount of student time it required when student abilities and other equally effective alternatives are taken into account.

It can also be assumed that instruction which is too difficult for a pupil might produce certain frustrations for the learner. This is not meant to mean that the instruction should always be easy and the pupil should never be confronted with a situation in which his intellectual abilities are taxed to some extent. This does reflect, however, that the instructional sequence should be so structured and managed to keep these frustrations at a minimum.

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[1] Bloom, op. cit.

[2] Thomas J. Karwin, "Instructional Design, Recorded Instruction and Faculty Interests," Occasional Paper No. 2 (Santa Cruz: Office of Instructional Services, University of California at Santa Cruz, April, 1968).

[3] William H. Lucio and John D. McNeil, Supervision: A Synthesis of Thought and Action (New York: McGraw-Hill Book Co., Inc., 1962).

Individualized instruction can be termed effective if it accomplishes its aim of bringing the student to mastery of the lesson's objective. Effectiveness, then, is a measure of the quality of instruction in terms of outcome. Efficiency, on the other hand, is a measure of how appropriate the instruction was for the student even though it resulted in mastery of the task. A student may have received, for a period during his learning of a task, instructional sequences which because of outcomes were ineffective. Once his lesson is revised, the student then proceeds to mastery. This situation can be contrasted with the student who masters the task on his first attempt. It is assumed then that the latter student received more efficient instruction than the former, but it was equally effective for each, when the outcomes are considered.

For this investigation, the efficiency and effectiveness of the instruction provided for an individual student are measured in terms of outcomes. Hence, the number of posttests needed for mastery is one criterion for the measure of instructional quality.

These measures are defined operationally for a unit of instruction as follows:

Quality of Instruction (High) - Instruction for which the student required only one posttest to master the unit's objectives.

Quality of Instruction (Low) - Instruction for which the student required more than one posttest to master the unit's objectives.

The other measure of instructional quality investigated was the pupil's reaction to his learning activities. Ideally, if his program of instruction is appropriate for him, he should be able to proceed with a comparatively minimum amount of hindrance. To ascertain the extent of this, the pupil was asked to answer this question: "Was this work hard or difficult for you?" in terms of one of these responses:

It was very easy.

It was easy.

It was all right.

It was hard.

It was very hard.

This inventory was administered after each Curriculum Embedded Test (CET) and an average score was computed for the unit.

3. Teacher - The research related to learning has demonstrated that the teacher is a powerful determiner of student behavior. Ryans,[1] Ripple[2] and Christensen[3] have all

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[1] David Ryans, "Some Relationships Between Pupil Behavior and Certain Teacher Characteristics," Journal of Educational Psychology, 52:82-90, April, 1961.

[2] Richard E. Ripple, "Affective Factors Influence Classroom Learning," Educational Leadership, 22:476-80, April, 1965.

[3] Clifford M. Christensen, "Relationship Between Pupil Achievement, Pupil Affect-Need, Teacher Warmth, and Teacher Permissiveness," Journal of Educational Psychology, 51:169-74, 1960.

noted the teacher variables that affect learning and non-cognitive qualities of pupils. The Morrison[1] and French[2] studies reflect that student attention may differ from teacher to teacher. Therefore, it is conceivable that students learning under one teacher may exhibit differing degrees of perseverance than students learning under other teachers.

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[1] Henry C. Morrison, The Practice of Teaching in the Secondary School (Chicago: University of Chicago Press, 1927).

[2] William C. French, "The Correlation Between Teaching Ability and Thirteen Measurable Classroom Activities" (unpublished master's thesis, University of Chicago, 1924).

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The basic purpose of this study is to identify the relationship between certain instructional variables and three measures of Perseverance. The data in the subsequent analyses were obtained from students learning elementary school mathematics under Individually Prescribed Instruction. The measures of Perseverance were obtained from classroom observations of the subjects studying in six Level E mathematics units. The measures of perceived difficulty of the individualized lessons were obtained from inventories administered during the study of the unit. Other necessary data were obtained from student records.

1. Relationship between Units of Study and Perseverance.

Carroll[1] points out that children bring to a task varying degrees of perseverance. This assumption is obviously true for tasks which differ in interest and need of varied amounts of motor coordination. The tasks selected for investigation in this study are six units of elementary school mathematics. These include topics in Numeration, Place

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[1] John B. Carroll, "A Model of School Learning," Teachers College Record, 64:723-32, 1963.

Value, Addition, Subtraction, Multiplication, and Combination of Processes. (See Appendix for description and objectives of these units.)

Four hundred sixty-eight (468) measures of the three indices of Perseverance were available for two hundred nineteen (219) subjects in grades two to six. The means and standard deviations of these measures are shown in Tables 3, 4, and 5.

TABLE 3

MEANS AND STANDARD DEVIATIONS FOR MEASURES OF ATTENDING TIME OF STUDENTS IN E-LEVEL UNITS (In Minutes)

	Num.	P.V.	Add.	Sub.	Mult.	C.O.P.	Total
Mean	25.3	26.2	25.7	25.8	25.5	24.7	25.5
S.D.	4.3	3.5	3.7	4.1	4.7	4.8	4.3
N	176	53	24	69	106	40	468

TABLE 4

MEANS AND STANDARD DEVIATIONS FOR MEASURES OF DISTRACTABILITY OF STUDENTS IN E-LEVEL UNITS (Number of Intervals of Sustained Attending to Task)

	Num.	P.V.	Add.	Sub.	Mult.	C.O.P.	Total
Mean	7.9	8.4	8.4	9.1	8.2	8.6	8.3
S.D.	3.5	4.0	4.4	5.4	4.5	4.8	4.3
N	176	53	24	69	106	40	468

TABLE 5

MEANS AND STANDARD DEVIATIONS FOR MEASURES OF ATTENTION SPAN OF STUDENTS IN E-LEVEL UNITS (In Minutes)

	Num.	P.V.	Add.	Sub.	Mult.	C.O.P.	Total
Mean	4.1	4.2	4.2	4.1	4.2	4.4	4.1
S.D.	2.5	2.6	2.7	2.8	2.5	2.9	2.6
N	176	53	24	69	106	40	468

The Attending Time (AT) index (Table 3) represents the number of minutes out of a possible sample time of thirty (30) minutes in which the subjects were working independently on their prescribed work in each unit. As explained earlier, some measures have been corrected to compensate for the time during the observations that the students were under direct teacher influence.

No striking differences are seen in the degree students attend to a particular unit. However, from these data it would appear that these students on the average attend to their tasks approximately five-sixths (5/6) of the time.

The Distractability index of Perseverance is a measure of the number of uninterrupted intervals of attending time in the thirty (30) minute sample time. The higher the measure is, the more distractable the student. Hypothetically this measure could reach infinity; a few cases were observed to be over twenty, but none exceeded thirty. Again, no wide inconsistencies were noticed in Table 4 except for the difference of over one period between Numeration and Subtraction units.

Table 5 shows measures of the Attention Span (AS) of the subjects for these units. This measure was not directly observed, but was computed from the Attending Time and the Distractability indices by the formula $AS=\frac{AT}{D}$. Here, also, no wide variance is noted. It would appear from these data that students in these units attend to these learning tasks as a group without interruption for an average of approximately four minutes.

Since these measures across the six units are not independent, i.e., the same student could contribute to the variance in more than one unit, the question of task influence was further analyzed.

Thirty-five (35) students were selected for which observational data were available for each of three units: Numeration, Subtraction and Multiplication. It was felt that the power of this analysis would be strengthened if, rather than using the sum of the three independent observations as was represented in the previous discussion, each of the scores in the three ten-minute observation periods for each unit would be represented. In following this procedure, the possibility of an interaction effect could be delineated in the analysis of variance. A Components of Variance model[1] was used since the independent variables are a representative sample of their populations. Since this model is employed, the interaction mean square is used to test the significance of the main effects.

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[1] Quinn McNemar, Psychological Statistics (2nd ed.; New York: John Wiley and Sons, Inc., 1955).

The analysis of variance table for student Attending Time for the three units is shown in Table 6. From the rather low F values for units and students, it would appear neither contribute to the variance in the time students appear to be studying their learning task. The significant interaction on the other hand, demonstrates that the Attending Time of a particular student is a function of the unit he is studying.

TABLE 6

ANALYSIS OF VARIANCE FOR NUMERATION,
SUBTRACTION AND MULTIPLICATION UNITS
vs. INDIVIDUAL ATTENDING TIME

Source of Variance	Sums of Squares	df	Mean Square	F
Units	5.8	2	2.9	0.40
Students	99.3	34	2.9	0.40
Interaction	491.9	68	7.2	2.4**
Error	630.8	210	3.0	
Total	1227.8	314		

**Significant at the .01 level.

Table 7 represents the analysis of variance of Distractability measures. No significant differences were found between units or among individuals; however, the null hypothesis of no interaction effects is rejected at the .01 level of significance. This indicates that the combination of a particular student with a particular unit accounts for variance in Distractability.

TABLE 7

ANALYSIS OF VARIANCE FOR NUMERATION, SUBTRACTION AND MULTIPLICATION UNITS vs. INDIVIDUAL DISTRACTABILITY

Source of Variance	Sums of Squares	df	Mean Square	F
Units	165.6	2	82.8	2.23
Students	418.3	34	12.3	0.33
Interaction	252.4	68	37.1	14.83**
Error	526.0	210	2.5	
Total	1362.3	314		

**Significant at the .01 level.

The data for Attention Span, or the average time a student spends in sustained application to his task, are shown by Table 8. Again, the difference among units is not significant. The presence of a significant interaction makes the interpretation of the significant student F somewhat difficult.[1] However, it, together with the significant interaction of student Attention Span and unit, shows that variance in Attention Span is very much a function of individual differences.

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[1] E. F. Lindquist, Design and Analysis of Experiment in Psychology and Education (Boston: Houghton Mifflin Co., 1953).

TABLE 8

ANALYSIS OF VARIANCE FOR NUMERATION, SUBTRACTION AND MULTIPLICATION UNITS vs. INDIVIDUAL ATTENTION SPAN

Source of Variance	Sums of Squares	df	Mean Square	F
Units	37.8	2	18.9	1.26
Students	999.4	34	29.4	1.96**
Interaction	1017.6	68	15.0	1.52**
Error	2087.0	210	9.9	
Total	4141.8	314		

**Significant at the .01 level.

The hypothesis that the unit would have a consistent influence on pupil Perseverance is rejected. The absence of a meaningful significant difference among students suggests that students do not differ consistently over all units in Perseverance. The continued presence of the interaction effect in this series of analyses suggests that the variance in Perseverance is a function of the particular unit in which these students are working.

2. Relationship between Measures of Instructional Quality and Perseverance.

Instructional quality is related to the degree to which the presentation, explanation and the ordering of the instructional elements approach the optimum for a given learner. The mechanics to reach this goal are available within an adaptive learning environment such as Individually

Prescribed Instruction. This investigation employs two measures of instructional quality in order to ascertain its contribution to the ability of students to be observably persevering in learning. These are: (1) a measure of the extent to which the instruction prescribed for a learner was effective and efficient and (2) a measure of the difficulty of the instruction as perceived by the learner.

Effectiveness and Efficiency of Instruction:

These terms when applied as measures of instructional quality have somewhat interrelated meanings. Effectiveness implies the extent to which the instruction resulted in mastery of the intended behavior, while efficiency connotes the degree of time needed for this effective instruction.

An essential element of Individually Prescribed Instruction[1] is the requirement that a student achieves a predetermined criteria of mastery for a particular learning task. Therefore, in this instructional environment, all instruction is considered to be effective if the child masters the posttest for the unit.

The efficiency aspect of instructional quality depends upon the characteristics of each learner and his resulting instructional plan. No absolute measures of this blend of characteristics and plan are at present obtainable. However, in the absence of such a measure, it is felt that the number of attempts made by a student to meet the mastery criterion would reflect this dimension of instructional quality. For classification purposes, Quality of Instruction is said to be "High" for those students who required only one posttest to master the unit and "Low" for those who required more than one.

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[1] C. M. Lindvall, "The Essential Elements of IPI," A Manual for the IPI Institute (Pittsburgh: Learning Research and Development Center, University of Pittsburgh, June, 1967), mimeograph.

To test the effect of Quality of Instruction on the three indices of Perseverance, a 2x2 analysis of variance schema was employed with the Quality of Instruction and instructional units as the independent variables. One hundred eighty (180) subjects were used in this analysis; forty-five (45) were classified in each of the four cells. The use of this classification permitted the investigator to again test for unit effects and the possibility of interaction of units and quality on each of the measures of Perseverance. This analysis was seen to be representative of a Mixed Model;[1] hence, the interaction mean square was used to test the main effects.

Table 9 represents the means of each combination of the two independent variables. No striking differences are noted, however, the data were submitted to a test of analysis of variance (Table 10).

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[1] McNemar, op. cit.

TABLE 9

ATTENDING TIME MEANS FOR UNITS vs. QUALITY OF INSTRUCTION (N=180)

Quality of Instruction	UNITS Numeration	 Multiplication	 Total (QI)
High	25.4	24.7	25.0
Low	25.5	25.4	25.6
Total (Units)	25.4	25.1	25.3

TABLE 10

ANALYSIS OF VARIANCE FOR ATTENDING TIME vs. QUALITY OF INSTRUCTION AND UNITS

Source of Variance	Sums of Squares	df	Mean Square	F
Units	6.16	1	6.16	2.40
Q.I.	6.85	1	6.85	2.66
Interaction	2.57	1	2.57	0.13
Within Cells	3581.17	176	20.35	
Total	3596.75	179		

From this analysis it is safe to conclude that neither the instructional quality as measured by the number of post-tests nor the task contributes to the variance of Attending Time for these subjects. The size of the within mean square in relation to the others reflects the wide deviations of the individual scores in each cell.

Table 11 shows the Distractability means for each cell and totals for each level of the independent variables. These means were analyzed using analysis of variance (Table 12) to identify the source of the variance in the data.

TABLE 11

DISTRACTABILITY MEANS FOR UNITS vs.
QUALITY OF INSTRUCTION (N=180)

	UNITS		
Quality of Instruction	Numeration	Multiplication	Total (QI)
High	7.7	8.8	8.3
Low	7.9	8.4	8.2
Total (Units)	7.8	8.6	8.2

TABLE 12

ANALYSIS OF VARIANCE FOR DISTRACTABILITY
vs. QUALITY OF INSTRUCTION AND UNITS

Source of Variance	Sums of Squares	df	Mean Square	F
Units	32.9	1	32.09	1.93
Q.I.	0.36	1	0.36	0.96
Interaction	3.75	1	3.75	0.23
Within cells	2923.78	176	16.61	
Total	2959.98	179		

Neither of the main effects, that is, instructional unit nor Quality of Instruction, appears to contribute to the variance of Distractability in this analysis. The continued absence of an interaction effect indicates that the quality of the materials and activities involved in a particular learning task or unit do not act differently on the Distractability of the subjects from task to task in this investigation.

The mean Attention Span for each cell is shown in Table 13. These means were submitted to analysis of variance (Table 14). It is quite obvious that pupils who received "High" Quality of Instruction did not differ in Attention Span from those who received "Low" Quality of Instruction over both units. The hypothesis of no interaction of units and instructional quality is also not rejected.

TABLE 13

ATTENTION SPAN MEANS FOR UNITS vs. QUALITY OF INSTRUCTION (N=180)

Quality of Instruction	UNITS		
	Numeration	Multiplication	Total (QI)
High	4.2	3.8	4.0
Low	4.1	4.0	4.1
Total (Units)	4.2	3.9	4.0

TABLE 14

ANALYSIS OF VARIANCE FOR ATTENTION SPAN
vs. QUALITY OF INSTRUCTION AND UNITS

Source of Variance	Sums of Squares	df	Mean Square	F
Units	2.76	1	2.76	2.79
Q.I.	0.48	1	0.48	0.48
Interaction	0.99	1	0.99	0.18
Within cells	979.48	176	5.57	
Total	983.71	179		

The absence of any significant differences in the foregoing analyses strongly suggests that efficiency of learning, when measured by the numbers of posttests required for mastery, does not affect the variance in student perseverance-in-learning. It is also meaningful to note that the learning task or unit, either by itself or in interaction with Quality of Instruction, is not a factor in student Perseverance.

Perceived Difficulty

Another question of concern to the investigator was the degree to which the student's perception of difficulty of instruction affected his Perseverance. An inventory was administered to each subject after he had completed each Curriculum Embedded Test (CET) in the units. He responded to the question, "Was this work hard or difficult for you?" with one of these responses:

It was very easy.

It was easy.

It was all right.

It was hard.

It was very hard.

An average score, based on the student's separate responses for each skill, was computed for each unit ranging from 1.0 (very hard) to 5.0 (very easy).

The response to this question is, in effect, a measure of the extent to which the instruction prescribed for the student was so ordered and planned that he could proceed through the unit with a minimum amount of perceived hindrance. The possible causes of this hindrance to learning could be: (1) inadequate diagnosis of entering behavior, (2) too large steps in the instructional process and/or (3) incompatability of the mode of instruction with the individual learner.

The means and standard deviations of perceived difficulty are presented in Table 15. Since no appreciable effects of tasks (or units) on Perseverance were found in the previous analysis, the subjects were selected in the following investigation without regard to unit. In so doing, it provided the investigator a larger population from which to draw subjects for study whereby the effect of Quality of Instruction and perceived difficulty on Perseverance could be studied simultaneously.

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TABLE 15

PERCEIVED DIFFICULTY OF STUDENTS' E-LEVEL MATHEMATICS UNIT (1-HARD; 5-EASY)

	Num.	P.V.	Add.	Sub.	Mult.	C.O.P.	Total
Mean	3.8	4.1	3.9	3.6	3.6	3.4	3.7
S.D.	0.6	0.8	0.7	0.9	0.7	0.8	0.8
N	176	53	24	69	106	40	468

To increase the power of the test of the effect of perceived difficulty on the three indices of Perseverance, it was felt that these measures should be combined with the efficiency measure of instructional quality. The available subjects were assigned to four groups without regard to unit of instruction. These groups were:

Group 1) High-Quality of Instruction - Instruction Easy
Group 2) High-Quality of Instruction - Instruction Hard
Group 3) Low-Quality of Instruction - Instruction Easy
Group 4) Low-Quality of Instruction - Instruction Hard

Subjects were assigned to the "High-Quality of Instruction" group if they required only one (1) posttest to master the unit. They were assigned to the "Low" group if they required more than one posttest. Each of these groups were then dicotomoized into cells based upon the scores on the difficulty inventory. They were assigned to the "Instruction Easy" group if their perceived difficulty score on the inventory was more than one standard deviation (0.8) from the mean of 3.7 for the entire pool of subjects, in this case, 4.5 or greater. Instruction was defined as "Hard" if they were more than one standard deviation below the mean (2.9 or less).

For the analysis of each index of Perseverance a 2x2 analysis of variance was employed. This Fixed Effects model[1] provided the opportunity to test both the mean effects of Quality of Instruction and perceived difficulty and their interaction on the indices of Perseverance.

Table 16 shows the mean Attending Time for each cell (N=29/cell). No drastic differences in cell means can be identified. However, cell means do differ in magnitude and in the direction one would suspect; that is, the students in the High-Easy cell were more attentive in terms of time than those in the Low-Hard cell.

TABLE 16

ATTENDING TIME MEANS FOR QUALITY OF INSTRUCTION vs. PERCEIVED DIFFICULTY (N=29/CELL)

Perceived Difficulty	Quality of Instruction		
	High	Low	Total
Easy	26.2	25.4	25.8
Hard	25.8	24.1	25.0
Total	26.0	24.8	25.4

The means were analyzed by analysis of variance (Table 17). Although the cell means differed, the magnitude was not significant to draw the conclusion that these variables acting singly or in combination have an appreciable effect on student Attending Time of these subjects. This is partly attributed to the wide variance of attending time in each cell.

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[1] Ibid.

TABLE 17

ANALYSIS OF VARIANCE OF ATTENDING TIME vs. QUALITY OF INSTRUCTION AND PERCEIVED DIFFICULTY

Source of Variance	Sums of Squares	df	Mean Square	F
Perceived Difficulty	19.70	1	19.70	.68
Q.I.	43.46	1	43.46	1.50
Interaction	6.75	1	6.75	.23
Within cells	3255.22	112	29.06	
Total	3325.13	115		

The number of intervals of attending to task or Distractability were analyzed for the same subjects as in the previous investigation. Their cell means are shown in Table 18. These means differ again in the order one would suspect, but not enough (Table 19) to conclude that these variables affected the Distractability.

TABLE 18

DISTRACTABILITY MEANS FOR QUALITY OF INSTRUCTION vs. PERCEIVED DIFFICULTY (N=29/CELL)

Perceived Difficulty	Quality of Instruction High	Quality of Instruction Low	Total
Easy	7.5	8.0	7.8
Hard	8.6	9.1	8.9
Totals	8.1	8.6	8.2

TABLE 19

ANALYSIS OF VARIANCE OF DISTRACTABILITY vs. QUALITY OF INSTRUCTION AND PERCEIVED DIFFICULTY

Source of Variance	Sums of Squares	df	Mean Square	F
Perceived Difficulty	35.31	1	35.31	1.79
Q.I.	7.76	1	7.76	.39
Interaction	0	1	0	0
Within cells	2206.48	112	19.70	
Total	2249.55	115		

The same analysis was used to test for source of variance in Attention Span of these same subjects. The Attention Span means (Table 20) do not appear to differ, except for the Low-Hard cell which is almost a minute less than the mean for the High-Easy subjects. The analysis of variance (Table 21) shows, however, that this variance cannot be attributed to the main effects or their interaction.

TABLE 20

ATTENTION SPAN MEANS FOR QUALITY OF INSTRUCTION vs. PERCEIVED DIFFICULTY (N=29/CELL)

Perceived Difficulty	Quality of Instruction High	Low	Total
Easy	4.6	4.7	4.6
Hard	4.5	3.8	4.1
Total	4.6	4.2	4.4

TABLE 21

ANALYSIS OF VARIANCE OF ATTENTION SPAN vs. QUALITY OF INSTRUCTION AND PERCEIVED DIFFICULTY

Source of Variance	Sums of Squares	df	Mean Square	F
Perceived Difficulty	9.44	1	9.44	1.09
Q.I.	4.06	1	4.06	0.47
Interaction	5.61	1	5.61	0.64
Within cells	974.06	112	8.70	
Total	993.17	115		

It can be concluded from these series of analyses that the degree of difficulty of an instructional sequence does not result in any statistically noticeable differences in these measures of Perseverance. Moreover, when instructional quality is measured over both efficiency and perceived difficulty, no differences in these indices are apparent. It was of interest to this investigator to note the constant, though not statistically significant, difference between the Perseverance in the High-Easy group and the Low-Hard group. This might suggest that a more complete measure of quality of instruction could serve to identify students at the two extremes of quality who did differ in their Perseverance.

The hypothesis that these measures of the quality of instruction for individualized lessons are related to differences in pupil perseverance is rejected in all instances. This suggests that no particular lesson or lesson form is generally more conducive to producing pupil attentiveness for all pupils than is any other lesson.

3. Relationship of Teachers and Student Perseverance.

It has been quite well established both from research and from informal observations of classrooms that the maintenance of an effective learning environment is a result of certain attributes of the teacher. The teacher's personality, talents as a tutor, and ability as a control agent should be reflected in the behavior of the students. It was therefore hypothesized that students in different classrooms working under different teachers would exhibit different degrees of Perseverance.

To test this hypothesis, four (4) classrooms of fifth grade students, each classroom having a different teacher, were compared for possible differences on the measures of Perseverance. Tables 22, 23, and 24 show the means for each measure over two units of instruction.

TABLE 22

MEAN ATTENDING TIME OF FIFTH-GRADE STUDENTS IN FOUR IPI CLASSROOMS STUDYING IN NUMERATION AND MULTIPLICATION UNITS

Unit	Room			
	A	B	C	D
Numeration	25.2	26.2	25.8	25.7
N	14	12	11	31
Multiplication	25.3	26.1	27.4	24.2
N	13	10	9	18

TABLE 23

MEAN DISTRACTABILITY OF FIFTH-GRADE STUDENTS IN FOUR IPI CLASSROOMS STUDYING IN NUMERATION AND MULTIPLICATION UNITS

Unit	Room			
	A	B	C	D
Numeration	6.2	7.4	7.3	9.3
N	14	12	11	31
Multiplication	6.5	6.7	6.0	10.9
N	13	10	9	18

TABLE 24

MEAN ATTENTION SPAN OF FIFTH-GRADE STUDENTS IN FOUR IPI CLASSROOMS STUDYING IN NUMERATION AND MULTIPLICATION UNITS

Unit	Room			
	A	B	C	D
Numeration	4.9	4.3	4.3	3.7
N	14	12	11	31
Multiplication	4.6	4.6	5.6	2.8
N	13	10	9	18

The means for each measure were analyzed by using a one-way analysis of variance. It was impossible to test both the effect of unit and teacher in the same analysis because the unit measures were not independent; that is, measures of some of the same students were in both units. Tables 25 through 30 give the resulting F ratios for each index and unit.

TABLE 25

ANALYSIS OF VARIANCE OF ATTENDING TIME OF FIFTH-GRADE CLASSROOMS FOR THE NUMERATION UNIT

Source of Variance	Sums of Squares	df	Mean Square	F
Between	7.01	3	2.34	0.15
Within	1010.99	64	15.80	
Total	1018.00	67		

TABLE 26

ANALYSIS OF VARIANCE OF ATTENDING TIME OF FIFTH-GRADE CLASSROOMS FOR THE MULTIPLICATION UNIT

Source of Variance	Sums of Squares	df	Mean Square	F
Between	66.72	3	22.24	1.21
Within	846.44	46	18.40	
Total	913.16	49		

TABLE 27

ANALYSIS OF VARIANCE OF DISTRACTABILITY OF FIFTH-GRADE CLASSROOMS FOR THE NUMERATION UNIT

Source of Variance	Sums of Squares	df	Mean Square	F
Between	98.57	3	32.86	2.65
Within	792.30	64	12.38	
Total	890.87	67		

TABLE 28

ANALYSIS OF VARIANCE OF DISTRACTABILITY OF FIFTH-GRADE CLASSROOMS FOR THE MULTIPLICATION UNIT

Source of Variance	Sums of Squares	df	Mean Square	F
Between	236.50	3	78.83	6.73**
Within	538.32	46	11.70	
Total	774.82	49		

**Significant at the .01 level.

TABLE 29

ANALYSIS OF VARIANCE OF ATTENTION SPAN OF FIFTH-GRADE CLASSROOMS FOR THE NUMERATION UNIT

Source of Variance	Sums of Squares	df	Mean Square	F
Between	13.77	3	4.59	.64
Within	472.53	64	7.38	
Total	486.30	67		

TABLE 30

ANALYSIS OF VARIANCE OF ATTENTION SPAN OF FIFTH-GRADE CLASSROOMS FOR THE MULTIPLICATION UNIT

Source of Variance	Sums of Squares	df	Mean Square	F
Between	55.83	3	18.61	3.84*
Within	223.43	46	4.85	
Total	279.26	49		

*Significant at the .05 level.

The results of these analyses show that the Distractability and Attention Span of one classroom group differ significantly from the others in the Multiplication Unit. No differences are noted in the Numeration Unit.

To check the possibility that instructional quality differences between these classroom groups could have contributed to the differences in Distractability and Attention Span, the Quality of Instruction and perceived difficulty scores were tabulated (Table 31). The measures of instructional quality in the Multiplication Unit of the students in Classroom D were not noticeably different when compared with the other three classrooms. Since initially the same instructional materials were available to all of these students and instructional quality does not differ, it is conceivable that this variance in these two measures of perseverance could be a result of teacher behavior.

TABLE 31

PER CENT OF STUDENTS EXPERIENCING SPECIFIED INSTRUCTIONAL QUALITY IN TWO MATHEMATICS UNITS IN FOUR FIFTH-GRADE CLASSROOMS

	Room			
Unit	A	B	C	D
Numeration				
High QI	14%	42%	45%	32%
Easy	7%	25%	9%	19%
Hard	0%	0%	0%	10%
Multiplication				
High QI	31%	60%	56%	33%
Easy	15%	10%	10%	38%
Hard	23%	20%	33%	11%

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

This study has been concerned with the problem of relating certain instructional variables to three observable measures of student perseverance-in-learning within an individualized instructional environment. Some indication of their complex relationship has been set forth by Carroll[1] and later supported by Bloom;[2] therefore, this investigation may be viewed as an attempt to identify instructional variables which affect the degree to which children persevere in their learning.

In this investigation, these specified variables were analyzed in terms of their effect on Perseverance: (1) the effect of learning task differences (mathematics units); (2) the effect of instructional quality as measured by the efficiency and perceived difficulty of the instruction prescribed for the student; and (3) the effect of the classroom teacher. Here, measures have been investigated singly and in some instances in combination to delineate the effect on each of the three indices of student Perseverance.

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[1] John B. Carroll, "A Model of School Learning," Teachers College Record, 64:723-32, 1963.

[2] Benjamin S. Bloom, "Learning for Mastery," Evaluation Comment, Vol. 1, No. 2, May, 1968.

Perseverance is defined by Carroll[1] as the amount of time the learner is willing to spend in learning. On the assumption that an indication of this state is partially observable, the three indices of Perseverance were derived from student observations made between September 1967 and January 1968. These indices are (1) Attending Time - an indication of the time a student attends to learning independent of another person; (2) Distractability - an indication of how the student attends in terms of the number of sustained periods of attending to learning; and (3) Attention Span - an indication of the length of time a student is willing to spend in sustained application to the task.

A. Summary

The results of this study can be summarized in terms of each of the instructional variables and their effect on student perseverance.

1. The effect of the learning task on Perseverance was first studied by determining if students studying in different units of the IPI Mathematics Continuum exhibit different amounts of Perseverance. This learning task variable, when analyzed both with individuals and with Quality of Instruction as the other independent variable, did not make a significant contribution to the variance of the indices of Perseverance. There is, however, fairly strong evidence of an interaction effect of task and individual student. This suggests that the extent to which the learning task or unit

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[1] Carroll, op. cit.

influences pupil perseverance depends upon the individual student. Any given unit of study is not generally more effective in eliciting more perseverance in studying for all students than is any other unit. Moreover, this finding tends to support Bloom's[1] contention that students appear to approach different learning situations with differing amounts of perseverance.

2. To ascertain the effect of the quality of the instructional experience on a student's Perseverance, two measures of the dimensions of the quality were used. One was a measure of the efficiency of the instruction provided in terms of learning outcomes. The other was a measure of the student's perception of the difficulty of his instructional sequence. There was insufficient evidence that the variables either singly or in combination contributed to the variance in perseverance as measured by the three indices.

3. The means of each index of Perseverance of four groups of fifth-grade students who studied under different teachers were compared. While no significant difference between means was found in the Numeration unit, the means of two indices (Distractability and Attention Span) were found to be significantly different at .01 and .05 levels respectively with the Multiplication unit. This finding lends some support to the hypothesis that the teacher may influence the level of perseverance of his students.

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[1] Bloom, _op_. _cit_.

4. A sub-problem in this investigation was the question of whether differences in Perseverance existed among individual students. When individuals and unit effects were delineated in Analysis 1, there was no evidence that individuals working in several units differed consistently over all units in the indices of Perseverance. The presence of a significant interaction suggests that subject differences do exist within units, but that these intersubject or interstudent differences depend upon the unit being studied.

B. Conclusions and Recommendations for Further Study

The analyses of data in this study suggest that the degree of student attention or Perseverance in a learning situation is not a general characteristic of a student that is essentially the same no matter what the learning task or the quality of instruction. They also indicate that the topic being studied or the instructional materials being used do not have effects on perseverance that are at all uniform over all pupils. A study of the influence of "quality of instruction" showed that such quality was also not a general determiner of pupil attention. Results indicate that the effect of a lesson on pupil perseverance depends upon the particular student. There is also some evidence that the performance of the teacher is a factor in pupil perseverance.

Generalizations from this study must, of course, be made with certain qualifications. It was conducted within the context of a particular program for individualized instruction, the IPI program, which operates under specified procedures and with particular types of materials. But these same qualifications would have to be made in connection with any investigation carried out within an on-going school operation. Keeping these delimitations in mind, certain inferences can be drawn concerning the determiners of pupil attention and perseverance in classrooms involving a high degree of independent study.

The lack of general impact of any given unit and its associated lesson materials together with a relatively large variance among pupils working on a given unit suggests the need for some variety in materials so that there is maximum opportunity for each student to be engaged in study that is interesting enough to hold his attention. The fact that quality of instruction, as measured by the success of pupils in passing the posttest the first time they attempt it, is not associated with attention indicates that merely providing pupils with lesson materials from which they can learn efficiently is not sufficient for securing attention. Of course, this latter result also raises the question of "How important is it to pupil progress to have a high degree of pupil attention and perseverance?" The present study has not attempted to answer this question, but it has yielded data which suggest this as a question for future research.

The finding that the impact of materials and of the general learning situation is relatively specific to the individual (as supported by significant interactions) suggests the need of working with the individual in the situation if attention is to be enhanced. This should mean trying to discover what must be done for each student. This appears to be the general goal of certain contingency management approaches which involve a careful study of the individual to determine what things are reinforcing to him in the development of his effectiveness as a learner. An investigation embodying this type of study of individual students might be a useful next step in research on individualized instruction.

Additional support for this latter inference is found in the finding of the present study that the teacher may be an important factor in pupil perseverance. If this is the case, it suggests the importance of further research to determine what it is about the teacher and his practices which enhances pupil perseverance-in-learning.

APPENDICES

APPENDIX A

BEHAVIORAL OBJECTIVES OF LEVEL E UNITS

Numeration

The pupil:

1. counts to 1,000,000 by reading or writing short sequences of numbers from any starting point;
2. identifies odd and even numbers and states rules for adding, subtracting, and multiplying two numbers; e.g., E + E = E; selects the rule when a numerical example is given and vice versa;
3. rounds numbers to tens and hundreds for comparison and for estimating answers in simple word problems;
4. gives the standard numeral for a 2, 3, or 4 place number written in words and writes a 2, 3, or 4 place number in words;
5. writes the correct decimal fraction for a common or mixed fraction having a denominator of either ten or one hundred and vice versa;
6. writes or selects number words for mixed decimal fractions to thousandths and vice versa;
7. converts mixed decimal fractions to thousandths to various other forms; e.g., pictures, common or mixed fractions, position on number line (limit whole numbers to 100);
8. orders a collection of pure and mixed decimal fractions; decimal part to thousandths, whole numbers to 100.

Place Value

The pupil:

1. identifies the place value of the thousands', ten thousands', hundred thousands' and millions' digit in numbers to 1,000,000 by writing or selecting equivalent expressions;

2. writes numbers to 1,000,000 in expanded notation in words or in numerals with plus signs; makes or completes a place value chart;

3. writes < or > to show the relationship between two numbers to 1,000,000;

4. uses multiples of ten to generalize known multiplication and division facts; uses factors to 5 x 10;

5. identifies the place value of digits in mixed decimal fractions to thousandths by writing or selecting equivalent expressions;

6. writes a decimal number as the sum of its whole number part plus its fractional part written as ☐/10 + ☐/100 + ☐/1000;

7. makes or completes a place value chart for mixed decimal fractions (whole numbers to 1000, decimal part to thousandths).

Addition

The pupil:

1. does column addition without carrying with three or more digit numbers and more than two addends;

2. supplies a missing addend in equations based upon the commutative principle; selects equation which demonstrates the commutative principle;

3. adds two or more place numbers using the associative principle (limit of four numbers);

4. adds with carrying for four or more place numbers with two addends;

5. adds two numbers with whole number parts to thousands and one or two decimal places (hundredths place); each number need not have the same number of decimal or whole number digits;

6. solves multiple-step word problems requiring addition skills mastered to this point.

Subtraction

The pupil:

1. performs subtraction with borrowing for four or more place numbers;
2. subtracts two numbers with whole number parts to thousands and one or two decimal places (to hundredths place); each number need not have the same number of decimal or whole number digits;
3. solves multiple-step word problems requiring subtraction skills mastered to this point.

Multiplication

1. uses repeated addition to solve multiplication problems for a one-place number times a one, two or more place number (introduce combinations through 9 x 9);
2. gives the products for multiplication combinations through 9 x 9 (timed mastery test);
3. supplies the missing factor for multiplication equations based upon the commutative principle; selects the equation which illustrates the commutative principle (include up to a one place factor times a two place factor);
4. uses the associative principle for multiplication to multiply more than two numbers with single digit factors;
5. uses the distributive principle with a single digit factor times a two digit factor to simplify multiplication problems: e.g., $29 \times 8 = (30-1) \times 8 = 240 - 8 = 232$;
6. performs multiplication with a one digit factor times a two digit factor; uses multiplication algorithm;
7. multiplies a one digit factor times a three or more digit factor; uses multiplication algorithm;
8. finds the squares of the numbers 1 to 10 and writes numbers in exponential form identifying the "base" and "exponent"; writes the exponential form for repeated factors;
9. uses the algorithm for muliplication by multiples of ten up to 100,000; e.g.,

$$\begin{array}{r} 28 \\ \mathrm{x}10 \\ \hline 280 \end{array} \qquad \begin{array}{r} 28 \\ \mathrm{x}100 \\ \hline 2800 \end{array}$$

10. multiplies a two digit number by a two digit number, using multiplication algorithm;

11. solves one or two-step word problems requiring multiplication skills mastered to this point.

Combination of Processes

The pupil:

1. adds and subtracts with and without carrying, numbers to 1000 (include money, time and systems of measurement skills to this point);

2. solves equations which use a letter (e.g., "n") as a variable, for all skills to this point;

3. multiplies and divides combinations through 9 x 9 or 81 ÷ 9 (timed mastery test);

4. supplies the missing sign <, >, = or ≠ with mixed expressions for addition, subtraction, multiplication, division for all skills learned to this point;

5. finds averages for numbers, sums to 1000;

6. selects principle, including associative, commutative, distributive, and inverse, for equations and expressions learned to this point; also selects an illustrative equation when a principle is given;

7. solves one or two-step word problems with all skills learned to this point.

APPENDIX B

OBSERVATION FORM

NAME________________________________ GRADE____________________

DATE________________________________ ROOM_____________________

OBSERVER____________________________

ACTIVITY TIME

	Second											Total	
The Student:												Minute	Second
Works with Others													
Works Independently													
Is Not Working													

APPENDIX C

DIFFICULTY INVENTORY

Objective________________

Name____________________________ Grade______________

Date____________________________ Room_______________

Was this work hard or difficult for you? (check one ✓)

_____ It was very easy.

_____ It was easy.

_____ It was all right.

_____ It was hard.

_____ It was very hard.

GIVE THIS TO YOUR AIDE WHEN YOU HAVE FINISHED IT.

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